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Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART V CANALS

(First Revision)

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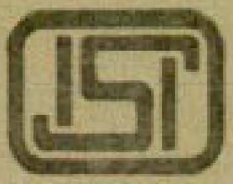

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PART V CANALS

(First Revision)

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GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART V CANALS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 25 February 1982, after the draft finalized by the Terminology Relating to River Valley Projects Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 A number of Indian Standards have already been published covering various aspects of river valley projects and a large number of similar standards are in the process of formulation. These standards include technical terms, the precise definitions of which are required to avoid ambiguity in their interpretation. To achieve this end, the Terminology Relating to River Valley Projects Sectional Committee is bringing out the Indian Standard Glossary of terms relating to river valley projects (IS : 4410) which is being published in parts. This part [IS : 4410 (Part V)] contains definitions of terms relating to the canals, section of canals and their lining.

0.2.1 This standard was first issued in 1968. The revision of this standard has been prepared to include certain additional terms in this standard. Many definitions of terms have also been modified as well as certain terms have been deleted

0.3 In the formulation of this standard due weightage has been given to international co-ordination among standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving considerable assistance from ' Multilingual technical dictionary on irrigation and drainage ' published by the International Commission on Irrigation and Drainage (ICID) and other sources. All the definitions taken from the Multilingual technical dictionary on irrigation and drainage are marked with asterisk(*).

1. SCOPE

1.1 This standard (Part V) contains definitions of terms relating to canal system, types of canals, design of canals, cross-section of canals, longitudinal section of canals and canal lining.

2. CANAL SYSTEM

2.1 Branch Canal — A canal receiving its supply from the main canal and acting as feeder for distributaries. It is also called ' Lateral '.

2.2 Canal — An artificial open channel carrying water including situations passing through tunnels enroute.

2.3 Contour Canal — A canal which is aligned nearly parallel to the contour of the area.

2.4 Distributary — A channel receiving its supply from main or the branch canal. It supplies water to minors and watercourses. It will be called a ' Major Distributary ' when it supplies water to another distributary called a ' Minor Distributary '.

2.4.1 *Major Distributary — See* **2.4.**

2.4.2 *Minor Distributary — See* **2.4.**

2.5 Escape — A channel through which surplus or excess water may be removed from a canal, stream or reservoir.

2.6 Field Channel — The channel that conveys water from water courses to the cultivators' fields.

2.7 Main Canal — The principal channel of a canal system off-taking from a river or a reservoir or a feeder. Also called ' Main Line '.

2.8 Minor — *See* **2.4.**

2.9 Ridge Canal or Watershed Canal — A canal in level ground or in sloping ground following, more or less, the ridge that divides the terrain into two or more gently sloping planes, making irrigation and distribution of water possible on both sides of the canal.

2.10 Tail Escape — An escape at the end of a channel in the distribution system intended to convey the surplus or unused water to a natural drain, depression, or other suitable place. It is also called ' Waste Channel '.

2.11 Waste Channel — *See* **2.10.**

2.12 Watershed Canal — *See* **2.9.**

2.13 Water Course — A channel taking off water from a branch canal, distributary or a minor to a delineated block of land. It may be built at Government expenses or by the beneficiary agriculturists depending upon the local irrigation practice and the area irrigated.

3. TYPES OF CANALS

3.1 Bypass Channel — A canal taking off from any source and returning back to the same source, further downstream after bypassing a canal power house.

3.2 Diversion Channel — A canal constructed to divert water from the main river.

3.3 Feeder Canal — A canal meant primarily either to convey water from one source of supply or system to another, or within the same system (also called Link Canal) or to a hydro power plant.

3.4 Hydel Channel — A canal or a reach of a canal, which is meant primarily to convey water to a power house.

3.5 Inundation Canal — A canal taking off from a river in flood without any permanent diversion or control structure across the river.

3.6 Irrigation Canal — A canal constructed primarily for conveying water from the source of supply to areas in which it can be used for irrigation.

3.7 Link Canal — *See* **3.3.**

3.8 Multipurpose Canal — A canal meant for two or more purposes such as irrigation, navigation, power generation, domestic and industrial water supply.

3.9 Navigation Canal — A canal which is primarily used for transportation by water.

3.10 Non-perennial Canal* — A canal meant to irrigate during only part of the year or particular season of the year. It is also called ' Seasonal Canal '.

3.11 Perennial Canal — A canal which carries water throughout the year.

3.12 Permanent Canal — A canal having a regular channel and masonry works for regulation and distribution, and with an assured source of supply.

3.13 Seasonal Canal — *See* **3.10.**

3.14 Power Channel — *See* **3.4.**

3.15 Side Canal — A canal adjacent to the parent canal to irrigate areas where direct irrigation from the parent canal is not feasible.

3.16 Tail Race Channel — A canal carrying tail water from a power house, back into the river.

4. TERMS RELATING TO DESIGN OF CANAL

4.1 Afflux — The upstream rise of water level above the normal surface of water in a canal or drainage channel, caused by an obstruction resulting in contraction of normal waterway.

4.2 Apron — A protective layer of stone or other material extending out from a structure on or in the bed of a channel or situated at some other location in the bed of a channel where it is desired to prevent erosion and/or hydrostatic uplift pressure.

4.3 Bed Load — The sediment in almost continuous contact with the bed, carried forward by rolling, sliding or hopping. Bed load can be subdivided into contact load and saltation load.

4.4 Bed Load Equation — The general relationship between bed load rate, flow condition and composition of the bed material.

4.5 Bed Load Function* — The rates at which various discharges will transport the different grain sizes of the bed material in a given channel.

4.6 Bed Slope — The difference in elevation of the bed per unit horizontal distance measured along the channel.

4.7 Canal Drop or Canal Fall — A structure designed to secure lowering of the water surface in a channel in a short distance and safe destruction of the liberated surplus energy. It may be vertical or inclined; in the latter case, it is usually called a chute.

4.8 Capacity Factor — The ratio of the mean supply to the authorized full supply or capacity (*see also* **5.21**).

4.9 Coefficient of Contraction — Ratio between the decreased length, area of section, or volume and the original length, area of section, or volume.

4.10 Coefficient of Discharge — A coefficient by which the theoretical discharge of water through orifices, weirs or other hydraulic structures, must be multiplied to obtain the actual discharge.

4.11 Coefficient of Roughness — A factor, in the Chezy, Darcy-Weisbach, Hazen-Williams, Kutter, Manning and ether formulae for computing the average velocity of flow of water in a conduit or channel which represents the effect of roughness of the confining material upon the energy losses in the flowing water. It is also called ' Coefficient of Rugosity ' or ' Rugosity Factor '. This is a dimensional parameter.

4.12 Coefficient of Velocity — The ratio of the actual velocity to the theoretical velocity.

4.13 Coefficient of Rugosity — *See* **4.11.**

4.14 Contact Load — The sediment that is rolling or sliding along the bed of the stream in substantially continuous contact with the bed.

4.15 Critical Depth — *See* IS : 1191-1971†.

4.16 Critical Flow

a) The flow in which the specific energy head is minimum for a a given discharge; under this condition the Fraude number will be equal to unity and surface disturbances will not just travel upstream; and

b) A condition of flow where the mean velocity is at one of the critical values, ordinarily at Belanger's critical velocity. Another important usage is in reference to Reynold's critical velocity at which the flow changes from stream line or non-turbulent to turbulent flow.

4.16.1 *Belanger's Critical Flow* — That flow in open channel at which the specific energy content of the liquid flowing is minimum.

4.16.2 *Reynold's Critical Flow* — Flow at that velocity which distinguishes turbulent motion from viscous motion.

4.17 Critical Tractive Force — Tractive force which starts general movement of the bed material.

4.18 Critical Velocity

4.18.1 *Belanger's Critical Velocity* — The velocity in a channel at which the specific energy content of the liquid flowing is minimum.

4.18.2 *Upper Critical Velocity* — The velocity at which eddy formation is first noted. Also called ' Upper Critical Velocity '.

†Glossary of terms used in measurement of flow of water in open channels (*first revision*).

4.18.3 *Lower Critical Velocity* — The velocity at which eddies in the flow die out.

4.18.4 *Reynold's Critical Velocity* — The velocity in a conduit or channel at which flow changes from laminar to turbulent.

4.19 Crop Ratio — The crop ratio is defined as the ratio between the anticipated crop areas to be irrigated to the total cropped area during a year.

4.20 Culturable Commanded Area — The gross area commanded less the area of unculturable land included in the gross area.

4.21 Datum*

a) An agreed standard point or plane of stated elevation, noted by permanent bench marks on some solid immovable structure, from which elevations are measured, or to which they are referred;

b) Any position or element in relation to which others are determined, for example, the horizontal control system used in map making; and

c) Any numerical or geometrical quantity or set of such quantities which may serve as a reference or base for other quantities.

4.22 Delta — A term equivalent to duty of water when the latter is expressed in water-depth units and refers to irrigation projects under operation. It is stated with reference to the place at which it is measured to reckoned, that is, delta at farm, delta at outlet, head of watercourse, or lateral head, delta at distributary head, delta at head of main canal.

4.23 Discharge — The volume of water flowing through a cross section of a channel in a unit time. It is also called ' rate of flow '.

4.24 Drowning Rate — Ratio of tail-water elevation to headwater elevation, when both are higher than the crest of the structure, the elevations being measured with the crest as reference datum; distance upstream and downstream from the crest at which head-water and tail-water elevations are to be measured should be such that levels are not influenced by the structure.

4.25 Duty or Duty of Water — The relation between the area irrigated, or to be irrigated, and the quantity of water used, or required, to irrigate it for the purpose of maturing its crop. Duty stated with reference to a

base period and the place of its reckoning or measurement. It is expressed in a number of ways as given below:

a) Water-depth units;
b) Depth area units per unit area;
c) Area per unit rate of flow or per unit volume of water; and
d) Volume of water or rate of flow per unit area.

4.26 End Sills — A vertical, stepped, sloped or dentated wall constructed at the d/s end of the stilling basin.

4.27 Energy Gradient — The difference in total energy head per unit horizontal distance measured in the direction of flow.

4.28 Equilibrium — An ideal condition towards which a channel is ever tending to develop. A channel is in equilibrium when the energy available due to the discharge and slope is just sufficient to carry the sediment charge without any tendency for the stream or channel to change its shape or slope; this entails every part of the cross-section being in equilibrium. In nature this is never fully attained.

4.29 Equivalent Roughness — It is the sand roughness which will yield the same limiting value of ' f ' (Darcy Weisbach resistance coefficient) as that of the given channel (or pipe).

4.30 Flow — The movement of a volume of water.

NOTE — This term should not be confused with ' Discharge ' or ' Rate of Flow '.

4.31 Fluming — The purposeful reduction of waterway of a channel below the normal either by a flume or a flumed structure.

4.32 Fluming Ratio — The ratio of the clear waterway ot the throat of a flume or flumed structure to the normal channel width [*see* IS : 4410 (Part XV/Sec 3)-1977†].

4.33 Friction Head (or Loss) — The head or energy lost at the result of the disturbances set up by the contact between a moving stream of water and its containing channel.

4.34 Friction Slope — The friction head lost per unit length of channel. For most conditions of flow the friction slope coincides with the energy gradient, but where a distinction is made between energy loss due to bends, expansions, impacts, etc, a distinction must also be made between the friction slope and the energy gradient. Friction slope is equal to the bed surface slope only for uniform flow in open channels.

†Glossary of terms relating to river valley projects : Part XV Canal structures, Section 3 Flumes.

4.35 Free Flow — A condition of flow through or over a structure where such flow is not affected by submergence of the existence of tail water.

4.36 Free Surface — The surface of a fluid in contact with the atmosphere.

4.37 Froude Number — The dimensionless number obtained by dividing the mean velocity by the propagation velocity of an infinitely small surface wave.

4.38 General Movement of Bed Load — The stage of movement when all sediment sizes of the bed material are in motion and the movement is strong enough to develop bed configuration.

4.39 Graded Sediment — A sediment having a uniform or equable distribution of particles from coarse to fine.

4.40 Gross Area — The total area within the extreme limits set for irrigation by a project system or canal.

4.41 Ground Water Table — Topmost surface of underground water layers excluding the capillary fringe (which is apparent as static water level where an open well or pit is dug).

4.42 Hydraulic Mean Radius — *See* **5.24.**

4.43 Isovels — Lines joining points of equal velocity.

4.44 Laminar Flow — *See* **2.1** of IS : 2951 (Part I)-1965†.

4.45 Mean Depth — *See* IS : 1191-1971‡.

4.46 Mean Velocity — *See* IS : 1191-1971‡.

4.47 Non-eroding Velocity — The velocity corresponding to a particular silt grade that will not cause any scour.

4.48 Non-silting Velocity — The velocity corresponding to a particular silt grade that will not allow silt to deposit.

4.49 Non-uniform Flow — Open channel flow is said to be non-uniform if the depth of flow is not the same at every section of the channel.

4.50 Open Channel — *See* IS : 1191-1971‡.

†Recommendations for estimation of flow of liquids in closed conduits: Part I Head loss in straight pipes due to frictional resistance.

‡Glossary of terms used in measurement of flow of water in open channels (*first revision*).

4.51 Permissible Velocity — The highest velocity at which water may be carried within permissible scour in a channel.

4.52 Point Velocity — The mean velocity of water at a point in an open channel flow or in conduit flow.

4.53 Rate of Flow — *See* **4.23**.

4.54 Reach — A length of open channel between two defined cross sections.

4.55 Regime Silt Charge — The minimum transported load consistent with a fully active bed.

4.56 Reynold's Number — *See* **2.6** of IS : 2951 (Part I)-1965†.

4.57 Rough Boundary — A solid boundary to the fluid in which the surface irregularities project through the laminar layer and cause turbulence.

4.58 Roughness Reynold's Number — A dimensionless parameter employed in open channel flow. It is also called ' Karman Number ' and is given by the expression:

$$R^k = k \frac{\sqrt{gRS}}{\nu}$$

where

k = height of equivalent sand roughness,

$\sqrt{gRS}$ = shear velocity, and

ν = kinematic viscosity.

4.59 Rugosity Factor — *See* **4.11**.

4.60 Saltation — Stream transportation of sediments by intermittent leaps or bounds.

4.61 Saltation Layer — The zone above the bed within which phenomenon of saltation occurs in flowing channel.

4.62 Saltation Load — The sediment bouncing and hopping along the bed of the channel or moved directly or indirectly by the impact of the bouncing particles.

†Recommendations for estimation of flow of liquids in closed conduits: Part I Head loss in straight pipes due to frictional resistance.

4.63 Saltation Load Discharge — The amount of material moved in unit time due to saltation.

4.64 Sedimentation — The process of deposition and subsidence of suspended matter carried by water, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material.

4.65 Sediment Diameter — The following definitions are applicable:

a) *Nominal Diameter* — *See* IS : 6339-1971†.

b) *Fall Diameter* — Diameter of a sphere of specific gravity 2·65 and having the same standard full velocity as that of the particle (in which case, the aspect of fall, namely, flaky, disc, needle-like, etc, must be specified). The standard fall velocity is the terminal fall velocity in quiescent distilled water of infinite extent and at 24°C.

c) *Sedimentation Diameter* — Diameter of the sphere of the same specific gravity and the same terminal settling velocity as the given particle in the same sedimentation fluid under the same condition.

d) *Sieve Diameter* — The size of the (square-shaped) sieve opening through which a given particle will just pass (defined generally only for particles larger than 0·062 5 mm).

NOTE — Sieve diameter is nearly equal to 0·9 times nominal diameter.

4.66 Sediment Charge — The ratio of the mean sediment discharge to the water discharge. It is ordinarily expressed in parts by weight of sediment per unit volume of water.

4.67 Sedimentation Concentration — The ratio of the weight of the sediment in a water sediment mixture to the total weight of the mixture expressed as a percentage.

4.68 Sediment Discharge Intensity — The weight of sediment transported per unit time per unit width.

4.69 Sediment Grade — The particle size or the weighted mean diameter of the particle sizes which constitute the sediment sample. The spread of the sizes and the uniformity coefficient are also relevant.

†Methods of analysis of concentration, particle size distribution and specific gravity of sediment in streams and canals.

4.70 Sediment Transport Function or Sediment Lift Function — The relationship which gives the capacity of the stream to transport the various sediment sizes of the bed material at different flows.

4.71 Sediment Sphericity (Shape Factor) — The ratio of the surface area of a sphere having the same volume as that of the particle to the surface area of the particle.

4.72 Side Slope — The tangent of the angle which the side of the open channel makes with the horizontal. The tangent of the angle or the side slope may be expressed as the number of units vertically on/in number of horizontal units.

4.73 Silt Factor — A factor 'f' in the Lacey's formula and is given by the following equation in regime channels:

$$f = 1{\cdot}76\sqrt{mr}$$

where

mr = average particle size in mm.

4.74 Sluice

a) A conduit, fitted with a gate, for carrying water at high velocity.

b) An opening in a structure through which anything flows, for example, water, ice or debris.

c) To cause water to flow at high velocities for wastage, for purpose of excavation, ejecting debris, transporting ways, etc.

4.75 Smooth Boundary — A surface whose equivalent roughness is sufficiently submerged under the laminar sublayer (about one-fourth is the ratio adopted).

4.76 Smooth Channel Flow — A flow in an open channel where the surface behaves hydraulically smooth.

4.77 Specific Bed Load Transport — The weight of the transported quantity of bed-load per unit width of bed per second, weighed dry or under water.

4.78 Specific Energy* — The energy of stream per unit weight referred to its bed; namely, depth plus velocity-head corresponding to mean velocity.

4.79 Stable Channel — Channel in which the bed and the sides remain sensibly stable over a substantial period of time in the control reach, and in which scour and deposition during the rising and falling floods is inappreciable.

4.80 Standard Fall Velocity — The average fall velocity that the particle would finally attain if falling alone in quiescent distilled water of infinite extent and at a temperature without boundary effect as specified in IS : 196-1966†. It is also called as terminal velocity.

4.81 Static Threshold Discharge* — The critical discharge in a channel at which material just begins to move.

4.82 Static Threshold Discharge Intensity — The discharge per unit width of a channel required to keep the material moving.

4.83 Steady Flow — A condition of flow with constant mean velocity at every point of flow.

4.84 Sub-critical Flow — The flow in which the Froude's number is less than unity.

4.85 Super Critical Flow or Hyper-Critical Flow — The flow in which the Froude's number is greater than unity.

4.86 Suspended Load — That part of the sediment load of a stream, which remains in suspension in the flowing water for considerable periods of time without contact with the stream bed.

4.87 Surface Velocity — *See* IS : 1191-1971‡.

4.88 Terminal Velocity — *See* **4.80**.

4.89 Threshold Velocity — The velocity required to move material of a given size. It is also called ' Competent Velocity ' or ' Critical Velocity '.

4.90 Time-Integration Sampling — The process of sampling over a considerable period of time to eliminate the variation of the sediment concentration with time.

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†Atmospheric conditions for testing (*revised*).

‡Glossary of terms used in measurement of flow of water in open channels (*first revision*).

4.91 Total Energy Head

a) The sum of kinetic, potential and pressure energies and is given by:

$$\left(\frac{P}{\rho g}\right) + \left(\frac{\alpha U^2}{2g}\right) + Z$$

where

P = pressure at a point under reference,

ρ = density of the fluid,

α = energy correction factor,

g = acceleration due to gravity,

U = mean velocity at section, and

Z = elevation of the point under reference above an assumed datum assumed at the same plane for longitudinal as well as cross-sectional comparisons.

4.92 Total Energy Line — The plot of the total (energy) head in the direction of flow.

4.93 Tractive Force — The force of running water exerted on the wetted perimeter of a channel bed in the tangential direction

4.94 Turbulence

a) This is a condition of flow in which various quantities, such as local velocity, pressure, etc, show a random variation with space and time so that statistically distinct average values can be obtained.

4.95 Turbulent Flow — *See* **2.3** of IS : 2951 (Part I)-1965†.

4.96 Uniform Flow — Open channel flow is said to be uniform if the depth of flow is the same at all sections of the channel. A uniform flow is necessarily steady.

4.97 Unstable Channel — An unlined earthen channel in which silting and/or scouring occurs.

4.98 Unsteady Flow — In unsteady flow, either the magnitude or the direction of the velocity or both together, will vary with time.

†Recommendations for estimation of flow of liquids in closed conduits: Part I Head loss in straight pipes due to frictional resistance.

4.99 Velocity Component — Rate of movement past a point in a specified direction. The maximum magnitude of this defines 'the velocity'.

4.100 Velocity Head — The energy per unit weight expressed as a head is obtained by dividing the square of the velocity by twice the acceleration due to gravity.

4.101 Velocity of Retreat — *See* IS : 1191-1971†.

4.102 Water Logging — Condition in an area representing the general rise of ground water table encroaching upon the root zone of crops normally grown in that area; generally referred to the occurence of water table within 1·5 metre of the general ground level.

4.103 Water Sediment Complex — Mixture of water and sediment in channels. This is called two-phase flow.

4.104 Wetted Perimeter — The length of the wetted boundary of a channel at a specified section for single channel flows.

5. TERMS RELATING TO CROSS-SECTION OF CANAL

5.1 Area — Cross-sectional area of a channel.

5.2 Bed Bars — Permanent structures constructed at intervals along the centre line or edge of the canal bed to indicate the design level and/or bed width (*see* Fig 1.).

5.3 Bed Width or Bottom Width — The distance between the extreme points at the bottom of a cross section (*see* Fig. 1).

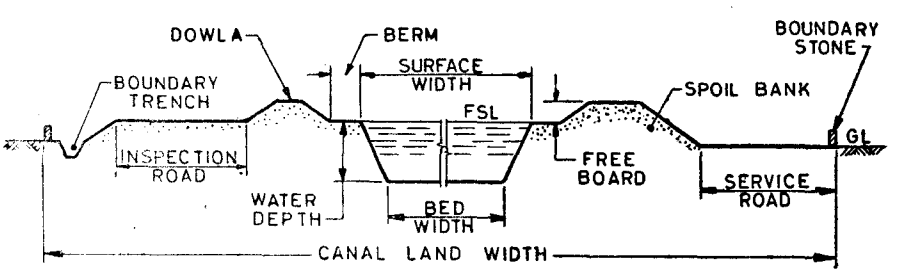

FIG. 1 A TYPICAL CROSS-SECTION OF A CANAL

†Glossary of terms used in measurement of flow of water in open channel (*first revision*).

5.4 Balancing Depth — Depth of a canal cross section such that the quantity of excavation is equal to the earthwork required for banks, generally applicable only to reaches.

5.5 Benching — Ledges shaped like steps or terrace formed below beds of canals and under the seats of banks in high filling for proper-bonding of earthwork with the natural ground (*see* Fig. 2).

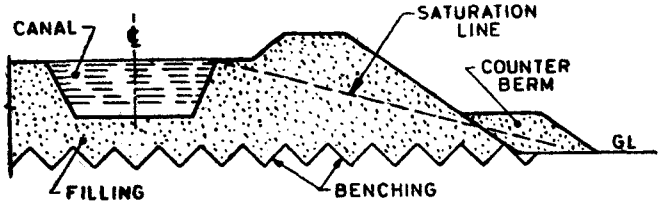

FIG. 2 CANAL IN FILLING

5.6 Berm or Inside Berm – The level surface left between the upper edge of the canal side slope and the inner toe of bank (*see* Fig. 1).

5.7 Borrow-Pit — A pit excavated for obtaining embankment material.

5.8 Boundary Stones — Stone marking boundary of land permanently acquired on either side of the canal (*see* Fig. 1).

5.9 Boundary Trench or Boundary Drain — A trench excavated near the outer extremity of land permanently acquired on either side of the canal (*see* Fig. 1).

5.10 Canal in Filling — A canal in which the bed level is at or above ground level (*see* Fig. 2).

5.11 Canal in Cutting — A canal in which the full supply level is at or below the natural ground level.

5.12 Canal Land Width — The width of land acquired for construction of a canal (*see* Fig. 1).

5.13 Counter Berm — An extra layer of earth (sloping, horizontal or broken horizontal steps) provided near the toe of outer slopes (toe away from the canal section) of banks to cover the line of saturation when it cuts the slope above the ground level (*see* Fig. 2).

5.14 Core Wall — A wall of concrete, masonry, sheet piling, puddle clay or some other impervious material, built inside a bank to reduce seepage and also to provide greater shear resistance.

5.15 Cross Section — A vertical section of the canal at right angles to the centre line or mean directions of flow.

5.16 Cross-Sectional Shape — The geometric shape of conveyance conduit, for example, rectangular, trapezoidal, semicircular and circular.

5.17 Cut-Off Wall — A wall or diaphragm of concrete or steel, or a trench filled with impervious earth or grout curtain, extending into the foundation of a dam, and either making a watertight connection with the dam or its impervious facing or extending into the body of the dam a considerable distance; its purpose is the prevention or reduction of passage of water under the dam and the foundation material or through the upper layers of the foundation material.

5.18 Depth — The vertical distance between the bed of a canal and the water surface line.

5.19 Dowla (Dowel) — A guard bank either on canal ride or on both edges primarily constructed to prevent cutting up of the slope due to rain and to keep the limits of the boundary road or inspection path and the inside slope of the bank discernible (*see* Fig. 1).

5.20 Free Board — The vertical distance between the full supply line in a channel and the top of the containing banks which is provided so that the water does not overtop the confining structure (*see* Fig. 1).

5.21 Full Supply Level — The level describing the water surface elevation under steady flow condition of maximum normal discharge (*see* Fig. 1). The discharge so carried is full supply discharge.

5.22 Hydraulic Grade Line — *See* **5.31**.

5.23 Hydraulic Gradient — The decrease in hydraulic head per unit distance in the soil in the direction of flow.

5.24 Hydraulic Mean Depth or Mean Radius — The value obtained by dividing the cross-sectional area of flowing water in a channel, by the wetted perimeter in the case of single flow sections.

5.25 Inspection Road or Inspection Path — Road either on the top of bank or on the berm or on the ground beyond the bank for inspection purpose (*see* Fig. 1).

5.26 Line of Saturation — *See* **5.31**.

5.27 Mean Depth — *See* **4.45**.

5.28 Non-inspection Bank — Bank of a canal which does not provide for an inspection path.

5.29 Percolation Line — *See* **5.31**.

5.30 Sand Core — Sand-filled depth in a bank to prevent the burrowing animals making holes.

5.31 Saturation Line — Line across the banks on either side of a canal in filling or partly in filling and partly in cutting up to which the banks get saturated after the canal has been running for some time (*see* Fig. 2). It is also called ' Line of Saturation ', ' Percolation Line ' or ' Hydraulic Grade Line '.

5.32 Scour Depth — It is the calculated depth of normal scour in a river or channel, below the water surface level in the river or channel. It has been conventionally expressed as:

$$1{\cdot}35\left(\frac{q^2}{f}\right)^{1/3}$$

where

q = discharge intensity per unit width, and

f = silt factor.

5.33 Service Road — Road on or outside the canal bank. It may serve for inspection purposes and also could be opened to public on a controlled basis (*see* Fig. 1).

5.34 Side Slope — *See* **4.72.**

5.35 Slip Failure — Slipping on sliding of an embankment on the side of a canal or any water retaining earth structure either due to instability caused like by sudden drawdown of the channel or water surface or for any other reason.

5.36 Spoil Bank — A bank composed of waste earth which has been excavated (*see* Fig. 1). It is also called ' Waste Bank '.

5.37 Surface Width — The width of the cross section at the water surface (*see* Fig. 1).

6. TERMS RELATING TO LONGITUDINAL SECTION OF CANAL

6.1 Alignment or Alinement — The course in plan along which the centre line of a canal is located.

6.2 Bed Levels — Levels (designed or average of the cross section) of the bed of a canal at any point along the centre line.

6.3 Bed Slope — *See* **4.6.**

6.4 Capacity Statement — In designing irrigation canals, a statement prepared for determining the discharge requirements of the canal reach by reach. It is also called ' Draw-off Statement '.

6.5 Draw-Off Statement — *See* **6.4.**

6.6 Cut-Off Statement — A statement showing cumulative discharges in a canal starting from the tail end, serially adding up the requirements of the distributaries including all admissible losses from the tail to head of the canal. It is similar to draw-off statement.

6.7 Field Command — The difference in water level, in a water course or lateral and the level of the highest point of piece of land irrigated.

6.8 Head Reach — The portion of a channel close to its offtake.

6.9 Longitudinal Section — A vertical section of a canal along its alignment. It is also called ' L-section ' or ' Profile Map '.

6.10 Longitudinal Water Surface Slope — The inclination of the water surface expressed as change of elevation per unit of horizontal length of the canal.

6.11 Natural Surface Levels or Ground Levels — Level of the natural ground surface with reference to a datum.

6.12 Outlet Statement — A statement showing the location capacity and the area irrigated by the outlets.

6.13 Reduced Distance (RD) — Distance of any point along the centre line of an irrigation canal measured from the point of its offtake from a river, stream, reservoir or a parent canal. If the distance is in kilometres, it is called ' Kilometrage '.

6.14 Ridges — The high line that divides the terrain into two or more gently sloping planes, making irrigation and distribution of water possible on both sides of the canal aligned more or less along it.

6.15 Superelevation — The difference in the bed levels between the two extreme points (inside and outside) of a canal on a curve.

6.16 Tail — The end of a channel.

6.17 Tail Reach — The last protion of a channel.

7. TERMS RELATING TO CANAL LINING

7.1 Asphaltic Concrete Lining — *See* **7.4.**

7.2 Backfill — Earth or other material placed behind linings or structure.

7.3 Bentonite Soil Lining — It is a type of earthen lining, where the earth in the lining is stabilized by mixing with bentonite emulsion.

7.4 Bitumen Cement Concrete Lining — A type of lining in which concrete is a mixture of bitumen cement and aggregates graded from fillers and fine sand to coarse gravel. Usually the concrete is placed while hot and compacted immediately. It is also called ' Asphaltic Concrete Lining ' or ' Hot Mix Asphalt Lining '.

7.5 Block Lining — *See* **7.26**.

7.6 Brick Lining — *See* **7.26**.

7.7 Built-Up Lining — A type of lining built-up *in situ* alternate layers of bitumen or asphalt and a supporting fabric, such as jute, cotton or fibreglass.

7.8 Burried Asphalt Membrane Lining (BAM) — A type of lining constructed by spraying a special bitumen or asphalt mix over a smooth subgrade to form a uniform, flexible, watertight membrane, which is then covered with a protective layer of earth and/or gravel.

7.9 Cement Concrete Lining — A type of rigid, smooth lining made of a mixture of cement and graded sand and either gravel or crushed stone. The lining may or may not be reinforced.

7.10 Cement Mortar Lining — A type of rigid, smooth lining made of a mixture of cement and sand.

7.11 Compacted Earth Lining — Compaction of natural subgrade soil below bed and sides of the canal with the object of utilizing the natural bond between soil particles to achieve a soil structure of greater strength.

7.12 Contraction Joints — Joints provided transversely, and also longitudinally in canal lining and filled with elastic material to allow movement in the structure without developing cracks.

7.13 Domali or Dwarf Wall — Walls built at intervals beneath the lining on sides as well as under bed.

7.14 Dwarf Wall — *See* **7.13**.

7.15 Earthen Section — Section of an irrigation channel having boundaries comprising of softer material of the lithosphere, such as silt and clay.

7.16 Expansion Joint — Joint provided, both in the transverse and longitudinal directions on the canal lining wherever needed to countervail effects of climatic variations.

7.17 Graded Filter — Inverted filter made up of two or three layers of properly designed and graded sieved permeable material, placed at the back of the canal lining, to allow release of seepage pressure in the natural soil underneath, whenever the flow in the canal is decreased (or discontinued).

7.18 Gunite — Gunite is a proportional combination of sand and cement which is mixed and pneumatically conveyed in a dry state to a nozzle, where water is added immediately prior to expulsion. Generally employed to render impermeability.

7.19 Hot Mix — A term commonly applied to a dense-graded mix of mineral aggregates, filler and bitumen; the mix must be laid whilst still hot.

7.20 Hot Mix Asphalt Lining — *See* **7.4.**

7.21 Lined Canal — A canal whose sides and bottom have been lined or covered with some watertight material to substantially prevent leakage or erosion or to improve carrying capacity, or to minimize growth of vegetation within the waterway.

7.22 Lined Section — Section of an irrigation channel protected with lining.

7.23 Lip Cutting — It is the extra width provided at the inner face of the bank under compaction to allow for any lapses in compaction due to inability of sheep foot rollers to cover the edge of the bank.

7.24 Lining — A protective covering overall, or over a portion, of the perimeter of a channel to prevent seepage losses, to withstand pressure or to resist erosion.

7.25 Made-Up Ground — The ground made from soil deposited and consolidated for the purpose of filling a depression or raising the level as required.

7.26 Masonry Lining — A type of canal lining involving the use of bricks, tiles, concrete blocks and stones. According to the construction used, they are respectively called ' Brick Lining ', ' Tile Lining ', ' Block Lining ' and ' Stone Lining '.

7.27 Polythene Lining — The canal lining in which the polythene sheets from the basic impermeable layer, although it may have protective cones of earth or masonry.

7.28 Pressure-Relief Valve — A valve provided in a canal lining which opens into the canal to relieve excess hydrostatic pressure behind the lining. The pressure-relief valve shall be such that it will operate at a differential pressure less than that which may be damaging to the lining with a factor of safety of two.

7.29 Puddle — A compact mass of soil, clay or their mixture, which has been compacted through the addition of water and rolling and tamping and made more or less impervious.

7.30 Sandwich Brick Tile Lining — Lining consisting of a layer of plaster on the subgrade and two layers of tiles with an impervious layer of cement mortar sandwiched in between.

7.31 Seepage — Flow of subsoil water through pores or fissures in the natural ground or rock under gravitational effects.

7.32 Sedimentation Lining — Lining of canals with bentonite or some chemicals which penetrate the canal bed material and seal it.

7.33 Seal Coat — A treatment of bitumen or outback applied to a surface to render it impervious or less pervious.

7.34 Sealing Compound — Sealing material placed at the construction or expansion joints of the canal lining, to prevent entry or exit of water through the joint.

7.35 Shotcrete — Pneumatically applied cement mortar consisting of an intimate mixture of cement, sand and water, shot into place by means of compressed air.

7.36 Sleeper Beam — Plain concrete beams placed under the construction or expansion joints in between the panels of cast *in situ* lining.

7.37 Slip Form — A steel plate curved up at the leading edge of the slip-form machine, extending across the bottom and up the slopes of the canal to assist in forming the finished surface of the lining.

7.38 Slip Form Lining — A concrete lining in which the cementing material is either bitumen or Portland cement which has been laid by means of a slip form.

7.39 Shotcrete Lining — Lining of shotcrete.

7.40 Soil Cement Lining — Lining consisting of a mixture of cement and soil, that is, the soil replacing the sand and gravel used in concrete.

7.41 Standard Soil-Cement — Soil-cement which is mixed at optimum moisture for maximum compaction as determined by the Proctor method.

7.42 Stone Lining — *See* **7.26.**

7.43 Subgrade — The surface specially prepared on which lining shall be laid.

7.44 Sudden Drawdown — Very quick fall in the water level in the canal.

7.45 Tile Lining — *See* **7.26.**

7.46 Toe Wall — A small plain concrete or masonry wall placed at the toe of the slope of concrete or tile linings or graded filters to prevent sliding of the lining or the filters and also to house the pressure release valves.

7.47 Under Drainge — Arrangements for proper drainage and release of seepage pressure from behind the canal linings.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	$1\ N = 1\ kg.m/s^2$
Energy	joule	J	$1\ J = 1\ N.m$
Power	watt	W	$1\ W = 1\ J/s$
Flux	weber	Wb	$1\ Wb = 1\ V.s$
Flux density	tesla	T	$1\ T = 1\ Wb/m^2$
Frequency	hertz	Hz	$1\ Hz = 1\ c/s\ (s^{-1})$
Electric conductance	siemens	S	$1\ S = 1\ A/V$
Electromotive force	volt	V	$1\ V = 1\ W/A$
Pressure, stress	pascal	Pa	$1\ Pa = 1\ N/m^2$

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